RESEARCH, DEVELOPMENT & TECHNOLOGY TRANSFER
QUARTERLY PROGRESS REPORT

Wisconsin Department of Transportation
DT1241 02/2011

INSTRUCTIONS:
Research project investigators and/or project managers should complete a quarterly progress report (QPR) for each calendar quarter during which the projects are active.

WisDOT research program category: ☐ Policy research ☒ Wisconsin Highway Research Program ☐ Other ☐ Pooled fund TPF#		Report period year: 2013 ☐ Quarter 1 (Jan 1 – Mar 31) ☒ Quarter 2 (Apr 1 – Jun 30) ☐ Quarter 3 (Jul 1 – Sep 30) ☐ Quarter 4 (Oct 1 – Dec 31)
Project title: Aesthetic Coatings for Bridge Components		
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WisDOT project ID: 0092-11-07	Other project ID:	Project start date: 10/21/2010
Original end date: 10/20/2012	Current end date: 6/30/2013	Number of extensions: 1

Project schedule status:

☒ On schedule ☐ On revised schedule ☐ Ahead of schedule ☐ Behind schedule

Project budget status:

Total Project Budget	Expenditures Current Quarter	Total Expenditures	% Funds Expended	% Work Completed
$145,000.00	$8,000.00	$140,000.00	96%	95%

Project description:

The objectives of this study are to investigate methods and products that may be used in the aesthetic and protection coating of bridge components and to develop a guideline for cost-effective bridge coating practices. It was envisioned that a series of coating systems for both steel and concrete would be identified and tested in the laboratory to evaluate their performance under simulated environmental conditions that are similar to those experienced by bridge components in Wisconsin. After conducting a preliminary investigation and holding discussions with the Project Oversight Committee (POC), it was approved by the POC that the focused should be placed on evaluation of only steel materials due to the extensive nature of the required investigation and scope of the current study. Wisconsin bridge sites, where coating failures and problems have occurred, have been visited to identify and evaluate the structural details and other factors that have contributed to such coating failures. Upon completion of the testing and evaluation program, guidelines and specifications language will be developed for selection, application, and maintenance of such coating materials. Also, recommendations will be made to WisDOT for implementation of the results of this study.

Progress this quarter (includes meetings, work plan status, contract status, significant progress, etc.):

During this quarter the research staff concluded all testing on the selected coating systems. A draft final report was complied documenting the entire study and its findings.

The draft final report included, but was not limited to the following items:

- Literature review
- Summary of survey results and field visits
- Documentation of the experimental procedure and results
- Guidelines for selection, surface preparation and application of coating systems

A summary of the results of this study is given in the following paragraphs:

This research project addressed the effectiveness of aesthetic steel coating systems used in bridges and their respective components. A total of twelve systems consisting of two-coat, three-coat, and duplex coating systems were subjected to a series of accelerated weathering tests to determine their performance. With an emphasis placed on aesthetics, the performance of these coating systems was based on gloss and color retention, coating discontinuities, rust creepage, and coating adhesion. In addition to the weathering tests, this study also focused on surface preparation and application procedures for various coating systems.

It was shown that proper adhesion of a duplex system can be obtained by following specific procedures for galvanization and surface preparation. Following these procedures resulted in pre and post weathering adhesion values from tests for liquid galvanized coating systems to exceed all but one of the non galvanized coating systems. Eliminating water quenching and chromate treatment by the galvanizer is essential to adhesion of a coating system. In addition, surface preparation needs to include a brush off blast of the galvanized surface. This brush off blast should be conducted at an angle between 30 and 60 degrees with a lower air pressure and a relatively soft blasting medium. This brush off blast is intended to produce a matte silver appearance with a surface profile around 1mil, and is not intended to remove or fracture any of the galvanization.

Three-coat fluoropolymer systems generally had the best color and gloss retention. In this study the difference between the performance of a three-coat fluoropolymer coating system and a three-coat polyurethane coating system was generally not significant. Of the two two-coat systems tested in this study one had similar performance to three-coat polyurethane coating systems and the other had a poor performance, experiencing significant color fading.

When comparing duplex polyurethane systems to their three-coat polyurethane counterparts the duplex systems had an overall better performance. This was primarily due to the added corrosion protection of the hot dip galvanization. For application on railings it is recommended to use liquid duplex systems. The complex geometry of railings creates many angles and sharp corners that leave many possibilities for improper coverage during application. Hot dip galvanizing not only provides proper coverage on the outside, but also the inside of the railings. In the event that the tie/top coat of the duplex system fails it is still protected by the galvanized steel preventing rust bleeding of the steel. Additionally, drilled holes at strategic locations in the railings that are needed for galvanizing prevents water from becoming trapped inside and damaging the railings. Deformed steel resulting in damaged coatings was seen on several un-galvanized railings on Wisconsin bridges. This damaged was the result of entrapped water freezing and expanding.

Both duplex powder coated systems tested in this study experienced out-gassing during initial application. This out-gassing was attributed to the galvanized substrate. Several attempts were made by the coating manufacturer to eliminate the out-gassing craters using a paraffin out-gassing agent. Although the number of craters were reduced they were not completely eliminated and it is not recommended to use these systems until this problem can be solved. The fluoropolymer powder coated system experience exceptional gloss and color retention, while the polyester powder coating system overall had poor color retention.

Anticipated work next quarter:

Complete the draft final report, submit to WHRP, implement comments by WHRP reviewers, submit the final report, and make a presentation of the results at an upcoming WHRP meeting.

Circumstances affecting project or budget:

The submission of the draft final report has been delayed due to difficulties ingrtting coating costs from the manufacturers. A 3-month no-cost time extension will be requested to complete all requirements of this contract.

Attach / insert Gantt chart and other project documentation

Quarters/Tasks	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
1. Literature Review											
2. Survey											
3. Interim Report											
4. Laboratory Testing											
5. Future Research											
6. Guidelines/Specs											
7. Draft Final report											
8. Final Report											

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Staff receiving QPR:	Date received:
Staff approving QPR:	Date approved:

Test Program
(Approved by POC on September 22, 2011)

Aesthetic Coatings for Bridge Components

WHRP Project # 0092-11-07

By

Al Ghorbanpoor and Zan Leppi
University of Wisconsin-Milwaukee

September 26, 2011

Introduction

To meet the requirements of the current WHRP study entitled "Aesthetic Coatings for Bridge Components," the research team submitted a proposal on September 14, 2011 to the Project Oversight Committee (POC) and WHRP to seek approval for the proposed testing program to be performed during the remaining term of this study. The proposal included two options which were both limited to testing coating systems for only new steel applications. The proposed options included a testing program of either 10 or 12 coating systems under two color schemes. The program as approved by the POC includes the 12-coating system option that consists of a slightly smaller number of test samples for the Xenon and Mandrel testing components. Through a correspondence on September 22, 2011, the POC forwarded to the research team a final approval for the test program as detailed below.

Approved Coating Systems and Test Program

The following table shows 12 coating systems for new steel applications, along with the number of samples, and the type of tests that will be performed on these coating systems. A description of each coating system is shown in appendix "A". There will be 5 samples per coating system for the UV/Prohesion/Freeze tests (Alternate ASTM D5894), and 2 samples per coating system for Mandrel testing. For Xenon testing, there will be 3 samples per coating systems tested with the following exception. The top-coats for coatings systems #A and #M and for #C and #N are the same so we will achieve the same results by performing tests on only coating systems #A and #C. Accordingly, we will eliminate the Xenon tests for coating systems #M and #N, to meet the space limitation of the Xenon testing equipment. For all UV/Prohesion/Freeze and mandrel tests, the Federal Color Number (27038) black will be used. For the Xenon tests, the Federal Color Number (27038) black and Federal Color Number (15092) blue will be used. Accordingly, a complete Xenon testing program of a minimum of 1,000 hours will be performed for samples coated with each selected color.

Approved 12 Coating Systems

System Type and #	Number of Systems	# of 3x6x1/8 in. Samples for UV/Prohesion/Freeze Testing (Alternate ASTM D5894)	# of 2x2x1/8in. Samples for Xenon Testing (ASTM G155)	# of 4x6x1/32in. Samples for UV/Prohesion/Freeze Mandrel Testing[2]
3-Coat Polyurethane (#A, #C, #Y)	3	15	9	6
3-Coat Fluoropolymer (#B, #Z)	2	10	6	4
2-Coat (#F, #0)	2	10	6	4
Galvanized Paint (#M, #N, #X)	3	15	3[1]	6
Galvanized Powder (#AA, #AB)	2	10	6	4
Total	12	60	30	24

[1] Tests applies to coating system #X only. Note that top coats are the same for coating #A and #M and for #C and #N.

[2] 2 samples per coating system will be tested under the Mandrel tests.

Appendix "A"
(Description of Coating Systems)

3-Coat Polyurethane Systems

Coating #	Manufacture	3-Coat System	Primer /DFT(mils)	Intermediate Coat /DFT(mils)	Top Coat /DFT(mils)
A	Sherwin Williams	Polyurethane	Zinc Clad III /(3-6)	Macropoxy 646 /(3-10)	Acrolon 218 HS /(3-6)
C	Carboline	Polyurethane	Carbozinc 859 /(3-5)	Carboguard 888 /(3-5)	Carbothane 133LH /(3-5)
Y	PPG	Polyurethane	Amercoat 68HS /(3)	Amercoat 399 /(4-8)	Amercoat 450H /(2-5)

3-Coat Fluoropolymer Systems

Coating #	Manufacture	3-Coat System	Primer /DFT(mils)	Intermediate-Coat /DFT(mils)	Top-Coat /DFT(mils)
B	Sherwin Williams	Fluoropolymer	Zinc Clad III /(3-6)	Macropoxy 646 /(3-10)	Fluorokem /(2.5-3)
Z	Carboline	Fluoropolymer	Carbozinc 859 /(3-5)	Carboguard 888 /(3-5)	Carboxane 950 /(2-3)

2-Coat Systems

Coating #	Manufacture	**1st Coat/DFT**(mils)	**2nd Coat /DFT**(mils)
F	Carboline	Carbozinc 859 /(5-7)	Carboxane 2000 /(7)
O	Sherwin Williams	Corothane I Galvapac Zinc /(3-4)	Polysiloxane XLE-80 /(3-7)

Galvanized Systems with Paint Coats

Coating #	Manufacture	**Tie-Coat/DFT**(mils)	**Top-Coat/DFT**(mils)
M	Sherwin Williams	Macropoxy 646 /(2-4)	Acrolon 218 HS /(2-4)
N	Carboline	Galoseal WB /(0.5-1)	Carbothane 133LH /(3-5)
X	Wasser	MC-Ferrox B 100 /(3-5)	MC-Luster 100 /(2-4)

Galvanized Systems with Powder Coat

Coating #	Manufacture	**Tie-Coat/DFT**(mils)	**Top-Coat/DFT**(mils)
AA	Sherwin Williams	EAS6-C000 Epoxy /(1.8-3)	AAMA 2605 Fluoropolymer /(2-3)
AB	Sherwin Williams	EAS6-C000 Epoxy /(1.8-3)	AAMA 2604 Polyester /(2-3)